



## **2005 ENERGY EFFICIENCY STANDARDS FOR LOW-RISE RESIDENTIAL BUILDINGS**

The 2005 Energy Efficiency Standards for low-rise residential buildings found in Title 24, Part 6, California Administrative Code, hereafter referred to as the Residential Standards, became effective October 1, 2005. The Residential Standards cover all low-rise residential occupancies, including:

- All single family dwellings of any number of stories
- All duplex buildings of any number of stories
- All multi-family buildings with three or fewer habitable stories
- Additions and alterations to all of the above buildings

The purpose of this bulletin is to identify the different approaches for compliance with the Residential Standards for new buildings and to provide guidelines for compliance with the prescriptive approach.

### **COMPLIANCE METHODS**

There are two general methods to demonstrate that a building meets the requirements set forth in the Residential Standards.

1. Prescriptive Approach: Consists of choosing one of the prescriptive packages for the applicable climate zone. Each individual component of the proposed building must meet a prescribed minimum energy requirement.
2. Performance Approach: This method of compliance allows for flexibility ("trade-offs" between different energy features) in meeting the energy requirements. The performance approach utilizes computer modeling to demonstrate compliance with the energy standards. For further information regarding State approved computer methods of compliance, please contact the California Energy Commission's Energy Hotline, weekdays between 8 A.M. and noon or between 1 P.M. and 3 P.M. at:

(800) 772-3300 Toll Free  
in California, or  
(916) 654-5106

or visit their web site at: <http://www.energy.ca.gov/title24>

## COMPLIANCE DOCUMENTATION

The following energy compliance documents are required to be submitted with the building plans:

- MF-1R, Mandatory Measures Checklist. The mandatory measures shall be permanently printed on the plans.
- CF-1R, Certificate of Compliance. The certificate of compliance shall be on the plans by means of printing the CF-1R information directly on the drawings. The documentation author, designer and owner shall sign the certificate of compliance.
- WS-4R, Fenestrations – Maximum Allowed Area Worksheet. This worksheet shall be completed and submitted to show compliance with prescriptive requirements.
- WS-5R, Residential Kitchen Lighting Worksheet. Required for all projects including kitchen lighting for prescriptive and performance compliance.

*Table 2-1 – Documentation Requirements, Prescriptive and Performance Compliance Methods*

Phase	Method	Documentation Required when applicable
Building Permit	Prescriptive and Performance	CF-1R, Certificate of Compliance
	Prescriptive and Performance	MF-1R, Mandatory Measures Checklist
	Prescriptive	WS-1R, Thermal Mass Worksheet Checklist
	Prescriptive	WS-2R, Area Weighted Average Calculation Worksheet
	Prescriptive	WS-3R, Solar Heat Gain Coefficient (SHGC)
	Prescriptive	WS-4R, Fenestration – Maximum Allowed Worksheet
	Prescriptive and Performance	WS-5R, Residential Kitchen Lighting Worksheet
	Prescriptive and Performance	CF-SR, Solar Water Heating Calculation Form
	Prescriptive and Performance	CF-4R, Certificate of Field Verification and Diagnostic Testing
Field Verification and/or Diagnostic Testing	Prescriptive and Performance	CF-4R, Certificate of Field Verification and Diagnostic Testing
Construction	Prescriptive and Performance	CF-6R, Installation Certificate

## INSTRUCTIONS FOR COMPLYING WITH THE PRESCRIPTIVE APPROACH

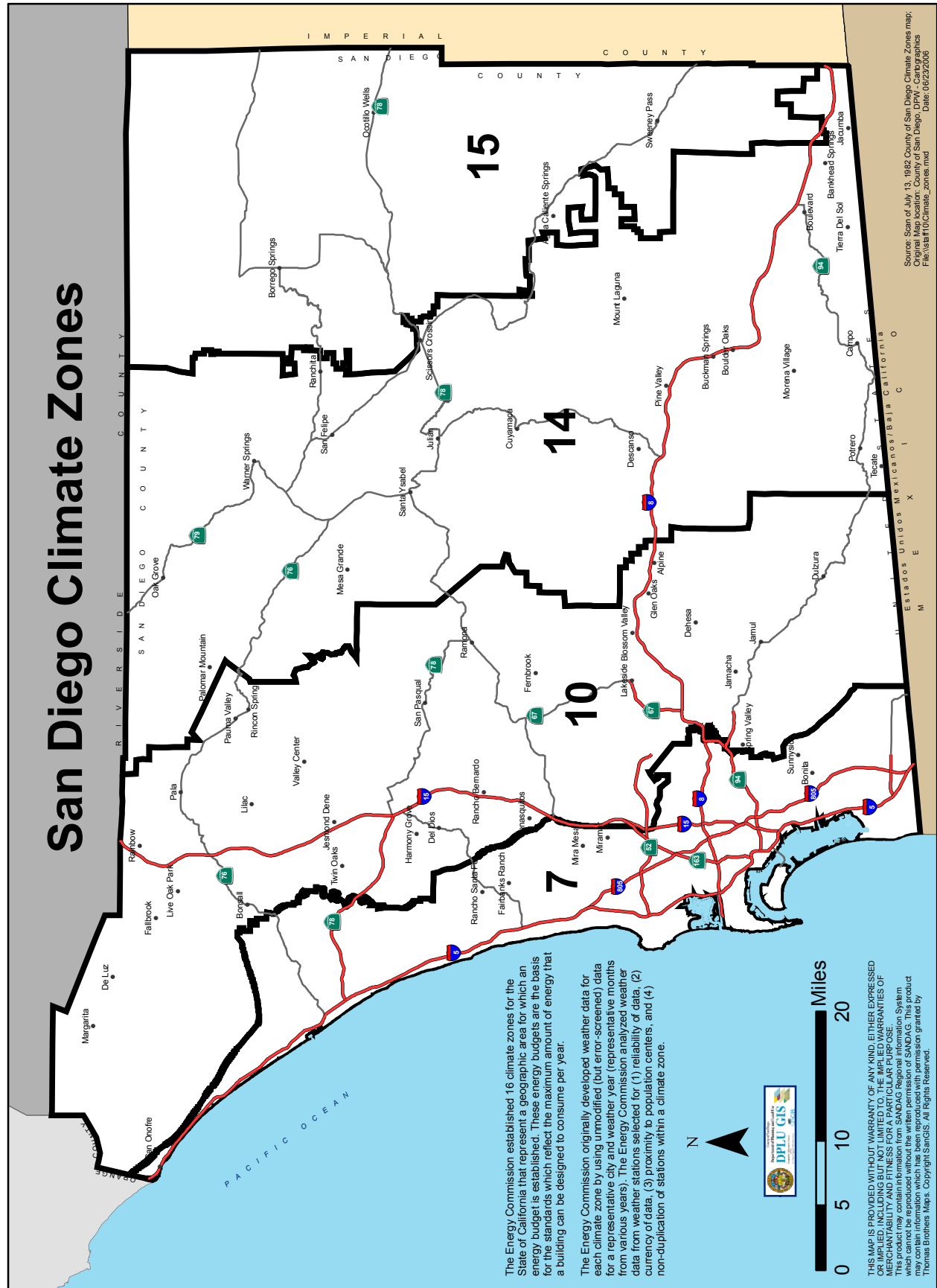
1. Determine the climate zone in which the proposed structure will be located (see attached Table 1 and the map of the San Diego County climate zones).
2. Select a package (C, D, or Alternate D) from the attached Prescriptive Packages within the climate zone in which the proposed building is located. The building must meet the minimum requirement for each building component.
3. Show on the certificate of compliance, form CF-1R, the minimum requirement for each building component. Also include the size, type and make of the heating equipment, cooling equipment (if applicable) and water heater. See Table 2 for recommended heating equipment sizing or see handout.

**TABLE 1**

**SAN DIEGO COUNTY CLIMATE ZONES**

<b>7</b>	<b>10</b>	<b>14</b>
BONITA DEL MAR LA MESA LEMON GROVE CANYON RANCHO SANTA FE SAN LUIS REY VISTA	ALPINE BARRETT JUNCTION BONSTALL DE LUZ DEL DIOS DULZURA EL CAJON ESCONDIDO FALLBROOK HARBISON CANYON JAMUL LAKESIDE LOWER OTAY RES. PALA PAUMA VALLEY POWAY RAINBOW RAMONA/SPAUDING, RINCON SPRINGS SAN MARCOS SAN PASQUAL SAN VICENTE RES. SANTEE SPRING VALLEY SWEETWATER RES. VALLEY CENTER	BOULEVARD CAMPO CUYAMACA DESCANSO EL CAPITAN DAM GUATAY HENSHAW DAM JACUMBA JULIAN LIVE OAK SPRINGS MORENA VILLAGE MOUNT LAGUNA OAK GROVE PALOMAR MOUNTAIN PINE VALLEY POTRERO RANCHITA SAN FELIPE TECATE THE WILLOWS TIERRA DEL SOL WARNER SPRINGS WITCH CREEK WYNOLA

<b>15</b>
AGUA CALIENTE SPRINGS BORREGO SPRINGS OCOTILLO WELLS VALLECITO STAGE STATION



**TABLE 151-B/C  
ALTERNATIVE COMPONENT PACKAGES  
FOR CLIMATE ZONE 7**

COMPONENT	PACKAGE		
	C	D	ALTERNATE D
<b>BUILDING ENVELOPE</b>			
Insulation Minimums <sup>2</sup>			
Ceiling	R38	R30	R30
Wood Frame Walls	R21	R13	R13
"Heavy Mass" Walls	NA	(R2.44)	(R2.44)
"Ligth Mass" Walls	NA	NA	NA
Below-grade Walls	NA	R0	R0
Slab Floor Perimeter	R7	NR	NR
Raised Floors	R21	R19	R19
Concrete Raised Floors	NA	R0	R0
<b>RADIANT BARRIER<sup>7</sup></b>	NR	NR	NR
<b>FENESTRATION / GLAZING<sup>3, 5</sup></b>			
Maximum U-factor	0.38	0.67	0.42
Maximum Solar Heat Gain Coefficient (SHGC)	0.40	0.40	0.40
Maximum Total Area <sup>4</sup>	14%	20%	20%
Maximum West Facing Area <sup>4</sup>	5%	5%	5%
<b>THERMAL MASS<sup>6</sup></b>	REQ	NR	NR
<b>SPACE-HEATING SYSTEM</b>			
Automatic Setback Thermostat <sup>8</sup>	REQ	REQ	REQ
Electric Resistance Allowed <sup>1</sup>	YES	NO	NO
If Gas, AFUE =	MIN	MIN	MIN
If Heat Pump, HSPF = <sup>9</sup>	MIN	MIN	MIN
Single Phase Packaged (7.7 effective 1/23/06)	6.6	6.6	6.6
Single Phase Split (7.7 effective 1/23/06)	6.8	6.8	6.8
<b>SPACE-COOLING SYSTEM</b>			
SEER = (13.0 Minimum effective 1/23/06)	MIN	MIN	MIN
If Split System, Thermostatic Expansion Valve or Refrigerant	NR	NR	NR
Charge Measurement <sup>11</sup>			
<b>DUCTS</b>			
Duct Sealing <sup>12</sup>	REQ	REQ	NR
Duct Insulation	R-8	R-4.2	R-4.2
<b>DOMESTIC WATER HEATING<sup>10, 13</sup></b>	System shall meet Section 151(f) 8 or Section 151(b)		

**LEGEND:** NR = Not Required, NA = Not Applicable, REQ = Required, MIN = Shall meet minimum

**TABLE 151-B/C**  
**ALTERNATIVE COMPONENT PACKAGES**  
**FOR CLIMATE ZONE 10**

COMPONENT	PACKAGE		
	C	D	ALTERNATE D
<b>BUILDING ENVELOPE</b>			
Insulation Minimums <sup>2</sup>			
Ceiling	R49	R30	R30
Wood Frame Walls	R25	R13	R13
"Heavy Mass" Walls	NA	(R2.44)	(R2.44)
"Lighth Mass" Walls	NA	NA	NA
Below-grade Walls	NA	R0	R0
Slab Floor Perimeter	R7	NR	NR
Raised Floors	R30	R19	R19
Concrete Raised Floors	NA	R0	R0
<b>RADIANT BARRIER<sup>7</sup></b>	REQ	REQ	REQ
<b>FENESTRATION / GLAZING<sup>3, 5</sup></b>			
Maximum U-factor	0.38	0.57	0.38
Maximum Solar Heat Gain Coefficient (SHGC)	0.40	0.40	0.31
Maximum Total Area <sup>4</sup>	16%	20%	20%
Maximum West Facing Area <sup>4</sup>	5%	5%	5%
<b>THERMAL MASS<sup>6</sup></b>	REQ	NR	NR
<b>SPACE-HEATING SYSTEM</b>			
Automatic Setback Thermostat <sup>8</sup>	REQ	REQ	REQ
Electric Resistance Allowed <sup>1</sup>	YES	NO	NO
If Gas, AFUE =	MIN	MIN	MIN
If Heat Pump, HSPF = <sup>9</sup>	MIN	MIN	MIN
Single Phase Packaged (7.7 effective 1/23/06)	6.6	6.6	6.6
Single Phase Split (7.7 effective 1/23/06)	6.8	6.8	6.8
<b>SPACE-COOLING SYSTEM</b>			
SEER = (13.0 Minimum effective 1/23/06)	MIN	MIN	13.0
If Split System,			
Thermostatic Expansion Valve or Refrigerant	REQ	REQ	NR
Charge Measurement <sup>11</sup>			
<b>DUCTS</b>			
Duct Sealing <sup>12</sup>	REQ	REQ	NR
Duct Insulation	R-8	R-6	R-6
<b>DOMESTIC WATER HEATING<sup>10, 13</sup></b>	System shall meet Section 151(f) 8 or Section 151(b)		

**LEGEND:** NR = Not Required, NA = Not Applicable, REQ = Required, MIN = Shall meet minimum

**TABLE 151-B/C**  
**ALTERNATIVE COMPONENT PACKAGES**  
**FOR CLIMATE ZONE 14**

COMPONENT	PACKAGE		
	C	D	ALTERNATE D
<b>BUILDING ENVELOPE</b>			
Insulation Minimums <sup>2</sup>			
Ceiling	R49	R38	R38
Wood Frame Walls	R29	R21	R21
"Heavy Mass" Walls	NA	(R4.76)	(R4.76)
"Ligth Mass" Walls	NA	NA	NA
Below-grade Walls	NA	R0	R0
Slab Floor Perimeter	R7	NR	NR
Raised Floors	R30	R19	R19
Concrete Raised Floors	NA	R8	R8
<b>RADIANT BARRIER<sup>7</sup></b>	REQ	REQ	REQ
<b>FENESTRATION / GLAZING<sup>3, 5</sup></b>			
Maximum U-factor	0.38	0.57	0.38
Maximum Solar Heat Gain Coefficient (SHGC)	0.40	0.40	0.31
Maximum Total Area <sup>4</sup>	14%	20%	20%
Maximum West Facing Area <sup>4</sup>	5%	5%	5%
<b>THERMAL MASS<sup>6</sup></b>	REQ	NR	NR
<b>SPACE-HEATING SYSTEM</b>			
Automatic Setback Thermostat <sup>8</sup>	REQ	REQ	REQ
Electric Resistance Allowed <sup>1</sup>	YES	NO	NO
If Gas, AFUE =	MIN	MIN	MIN
If Heat Pump, HSPF = <sup>9</sup>	MIN	MIN	MIN
Single Phase Packaged (7.7 effective 1/23/06)	6.6	6.6	6.6
Single Phase Split (7.7 effective 1/23/06)	6.8	6.8	6.8
<b>SPACE-COOLING SYSTEM</b>			
SEER = (13.0 Minimum effective 1/23/06)	MIN	MIN	16.0
If Split System,			
Thermostatic Expansion Valve or Refrigerant	REQ	REQ	NR
Charge Measurement <sup>11</sup>			
<b>DUCTS</b>			
Duct Sealing <sup>12</sup>	REQ	REQ	NR
Duct Insulation	R-8	R-8	R-8
<b>DOMESTIC WATER HEATING<sup>10, 13</sup></b>	System shall meet Section 151(f) 8 or Section 151(b)		

**LEGEND:** NR = Not Required, NA = Not Applicable, REQ = Required, MIN = Shall meet minimum

**TABLE 151-B/C**  
**ALTERNATIVE COMPONENT PACKAGES**  
**FOR CLIMATE ZONE 15**

COMPONENT	PACKAGE	
	C	D
<b>BUILDING ENVELOPE</b>		
Insulation Minimums <sup>2</sup>		
Ceiling	R49	R38
Wood Frame Walls	R29	R21
"Heavy Mass" Walls	NA	(R4.76)
"Lighth Mass" Walls	NA	NA
Below-grade Walls	NA	R0
Slab Floor Perimeter	R7	NR
Raised Floors	R21	R19
Concrete Raised Floors	NA	R4
<b>RADIANT BARRIER<sup>7</sup></b>	REQ	REQ
<b>FENESTRATION / GLAZING<sup>3, 5</sup></b>		
Maximum U-factor	0.38	0.57
Maximum Solar Heat Gain Coefficient (SHGC)	0.40	0.40
Maximum Total Area <sup>4</sup>	16%	20%
Maximum West Facing Area <sup>4</sup>	5%	5%
<b>THERMAL MASS<sup>6</sup></b>	REQ	NR
<b>SPACE-HEATING SYSTEM</b>		
Automatic Setback Thermostat <sup>8</sup>	REQ	REQ
Electric Resistance Allowed <sup>1</sup>	YES	NO
If Gas, AFUE =	MIN	MIN
If Heat Pump, HSPF = <sup>9</sup>	MIN	MIN
Single Phase Packaged (7.7 effective 1/23/06)	6.6	6.6
Single Phase Split (7.7 effective 1/23/06)	6.8	6.8
<b>SPACE-COOLING SYSTEM</b>		
SEER = (13.0 Minimum effective 1/23/06)	MIN	MIN
If Split System,		
Thermostatic Expansion Valve or Refrigerant	REQ	REQ
Charge Measurement <sup>11</sup>		
<b>DUCTS</b>		
Duct Sealing <sup>12</sup>	REQ	REQ
Duct Insulation	R-8	R-8
<b>DOMESTIC WATER HEATING<sup>10, 13</sup></b>	System shall meet Section 151(f) 8 or Section 151(b)	

\*\*No alternate Package D in Climate Zone 15

**LEGEND:** NR = Not Required, NA = Not Applicable, REQ = Required, MIN = Shall meet minimum



## **NOTES TO THE LOW-RISE RESIDENTIAL ALTERNATIVE COMPONENT PACKAGES TABLES**

1. Package C is the only package that allows electric resistance space heating. Package C may be used only if the building is in an area (1) where natural gas is not currently available and (2) where extension of natural gas service is impractical, as determined by the natural gas utility.

New electric resistance heating systems are prohibited in alterations unless the system being replaced is an electric resistance heating system. If the existing system is gas, propane or LPG, then new electric resistance systems are not permitted.

2. The R-values shown for ceiling, wood frame wall and raised floor are for wood-frame construction with insulation installed between the framing members. For alternative construction assemblies, see Section 151 (f) 1 A. The heavy mass wall R-value in parentheses is the minimum R-value for the entire wall assembly if the wall weight exceeds 40 pounds per square foot. The light mass wall R-value in brackets is the minimum R-value for the entire assembly if the heat capacity of the wall meets or exceeds the result of multiplying the bracketed minimum R-value by 0.65. Any insulation installed on heavy or light mass walls must be integral with, or installed on the outside of, the exterior mass. The inside surface of the thermal mass, including plaster or gypsum board in direct contact with the masonry wall, shall be exposed to the room air. The exterior wall used to meet the R-value in parentheses cannot also be used to meet the thermal mass requirement.
3. The installed fenestration products shall meet the requirements of Section 151 (f) 3 and Section 151 (f) 4. Fenestration products shall be certified for overall U-factors as rated in accordance with the National Fenestration Rating Council, or the Default Fenestration Product U-factors per attached Table 116-a may be used. For glazing U-factor rating procedures and labeling requirements see Section 116.
4. The maximum total glazing area is listed as a percentage of the conditioned floor area. For Package D, the west-facing fenestration area shall not exceed the percentage of conditioned floor area specified. West-facing fenestration area includes skylights tilted to the west or tilted in any direction when the pitch is less than 1:12.
5. Values specified are maximum allowable values. If the package specifies a solar heat gain coefficient the requirements shall be met by either:
  - A. Installing fenestration products, except for skylights, that have an area weighted average SHGC equal to or lower than those shown. Skylights shall have an SHGC equal to or lower than those shown in tables. The solar heat gain coefficient of installed fenestration products shall be determined in accordance with Section 116; or
  - B. An exterior operable louver or other exterior shading device that meets the required solar heat gain coefficient; or
  - C. A combination of exterior shading device and fenestration product to achieve the same performance as achieved in Item A.
  - D. For south-facing glazing by optimal overhangs installed so that the south-facing glazing is fully shaded at solar noon on August 21 and substantially exposed to direct sunlight at solar noon on December 21.

Except where the CBC requires emergency egress, exterior shading devices must be permanently attached to the outside of the structure with fasteners that require additional tools to remove (as opposed to clips, hooks, latches, spans, or ties).
6. If the package requires thermal mass, the thermal mass shall meet the requirements of Section 151 (f) 5.
7. If a radiant barrier is required see Section 3.3.3 and Appendix D, attached. Show all requirements for the radiant barrier on the plans.
8. Automatic setback thermostats shall be installed in conjunction with all space-heating systems in accordance with Section 151 (f) 9.
9. HSPF means "heating seasonal performance factor."

10. Electric-resistance water heating may be installed as the main water heating source in Package C only if the water heater is located within the building envelope and a minimum of 25 percent of the energy for water heating is provided by a passive or active solar system or a wood stove boiler. A wood stove boiler credit shall not be used in Climate Zones 8, 10, and 15, nor in localities that do not allow wood stoves.
11. When refrigerant charge measurement or thermostatic expansion valves are required, ducted split system central air conditioners and ducted split system heat pumps shall either have refrigerant charge measurement confirmed through field verification and diagnostic testing in accordance with procedures set forth in the ACM Manual or shall be equipped with a thermostatic expansion valve (TXV) with an access door or removable panel to verify installation of the TXV. All TXV's shall be confirmed through field verification by HERS rater.
12. Sealed ducts to have less than 6% leakage (must be field verified by HERS rater).
13. Domestic water heater systems which meet the budget include:
  - storage gas units of 50 gallons or less
  - instantaneous gas water heaters

### **ADDITIONAL NOTES FOR THE PRESCRIPTIVE PACKAGE TABLES**

1. A fenestration product is any transparent or translucent material plus any sash frame and dividers in the envelope of the building (i.e., windows, sliding glass doors, french doors, skylights).
2. Fenestration products must have a temporary label indicating the U-factor and solar heat gain coefficient (SHGC) based on either the CEC default or the National Fenestration Rating Council (NFRC) Rating Procedures (see attached example). The temporary label shall not be removed before inspection by the County. Exception: Field-fabrication products are not required to be labeled.
3. The use of building cavities as ducts is no longer allowed; ducts must be installed. The use of cloth-backed rubber duct tape is no longer allowed unless used in combination with mastic and drawbands. Mechanical fastening of ducts connections is required. All supply ducts must either be in conditioned space or be insulated to a minimum of R-4.2.
4. The California Energy Commission approves home energy rating system (HERS) providers in California who conform with California HERS regulations (Title 20, Chapter 4, Article 8, Sections 1670-1676). Approved HERS providers are authorized to certify raters and maintain quality control over ratings. Ratings are based on visual inspection and diagnostic testing of the physical characteristics and energy efficiency features of houses, as constructed.
5. The following paragraphs summarize the responsibilities of the parties involved with regard to testing and inspecting for Duct Sealing.

#### **Builders**

Builders contract with an approved HERS rater who provides the builder with inspection, and diagnostic testing. The HERS rater also completes and provides Certificate of Field Verification and Diagnostic Testing (CF-4R) forms to the builder for submittal to the building department, and, if necessary, notifies the builder of corrective action needed to insure that moves comply.

#### **Installers**

Installers complete diagnostic testing required for compliance credit for each house, and certify testing results and that the work meets the requirements for compliance credit on the Installation Certificate, CF-6R. Installers work is then subject to field verification by approved HERS rater.

#### **HERS Rater**

Approved HERS raters conduct the field verification diagnostic testing and inspections, and provide Certificate of Field Verification and Diagnostic Testing (CF-4R) forms or notification that corrective actions are needed. HERS raters must be independent of both the builder and sub-contractor who installed the duct systems being field verified, and can have no financial interest in making corrections to the systems. As special inspectors HERS raters cannot be employed by sub-contractors or parties, other than the builder, whose work they are evaluating.

CERTIFICATE OF COMPLIANCE: RESIDENTIAL		(Page 1 of 5)	CF-1R
Project Title		Date	Building Permit #
Project Address			
			Plan Check / Date
Documentation Author		Telephone	Field Check / Date
Compliance Method (Prescriptive)		Climate Zone	Enforcement Agency Use Only

Alternative Component Package Method: (check one) \_\_\_\_\_ C \_\_\_\_\_ D \_\_\_\_\_ D (Alternative)

- Package C and Package D choices require HERS rater field verification and/or diagnostic testing (see CF-1R page 3)
- For Package D Alternative see Appendix B Table 151-C Footnotes 8-14 in the Residential Compliance Manual (RCM)

## GENERAL INFORMATION

Total Conditioned Floor Area (CFA) \_\_\_\_\_ ft<sup>2</sup>

Average Ceiling Height: \_\_\_\_\_ ft

Check Applicable Boxes

Building Type: (check one or more) \_\_\_\_\_ Single Family \_\_\_\_\_ Multifamily \_\_\_\_\_ Addition \_\_\_\_\_ Alteration  
(If adding fenestration fill-out WS-4R, Fenestration Maximum Allowed Area Worksheet and see Section 8.3.2 for Additions and 8.3.3 for Alterations in the RCM.)

- Maximum Allowed Total Fenestration Area \_\_\_\_\_ ft<sup>2</sup> (from WS-4R)
- Maximum Allowed West Facing Fenestration Area \_\_\_\_\_ ft<sup>2</sup> (from WS-4R)
- Number of Stories: \_\_\_\_\_ Number of Dwelling Units: \_\_\_\_\_
- Floor Construction Type: \_\_\_\_\_ Slab/Raised Floor (circle one or both)
- Front Orientation: \_\_\_\_\_ North / South / East / West : All Orientations (input front orientation in degrees from True North and circle one).

☐ **RADIANT BARRIER** (check box if required in climate zones 2, 4, 8-15)

## OPAQUE SURFACES INCLUDING OPAQUE DOORS

Component Type (Wall, Roof, Floor, Slab Edge, Doors)	Frame Type (Wood or Metal)	Cavity Insulation R-Value	Continuous Insulation R-Value	Assembly U-factor (for wood, metal frame and mass assemblies) <sup>1</sup>	Joint Appendix IV Reference	Roof Radiant Barrier Installed <sup>2</sup> Yes or No	Location Comments (attic, garage, typical, etc.)

1) See Joint Appendix IV in Section IV.2, IV.3, and IV.4, which is the basis for the U-factor criterion. U-factors can not exceed prescriptive value to show equivalence to R-values.

2) This column is for the Inspector to verify installation of roof radiant barrier.

*Project Title**Date***FENESTRATION PRODUCTS – U-FACTOR AND SHGC**

✓ ☐ FENESTRATION MAXIMUM ALLOWED AREA WORKSHEET WS-4R – must be included for New Construction, Additions, and Alterations.

Fenestration #/Type/Pos. (Front, Left, Rear, Right, Skylight)	Orien- tation, N, S, E, W <sup>1</sup>	Area (ft <sup>2</sup> )	U-factor <sup>2</sup>	U-factor Source <sup>3</sup>	SHGC <sup>4</sup>	SHGC Source <sup>5</sup>	Exterior Shading/Overhangs <sup>6, 7</sup> ✓ box if WS-3R is included
							<input type="checkbox"/>
							<input type="checkbox"/>
							<input type="checkbox"/>
							<input type="checkbox"/>
							<input type="checkbox"/>
							<input type="checkbox"/>
							<input type="checkbox"/>

- 1) Skylights are now included in West-facing fenestration area if the skylights are tilted to the west or tilted in any direction when the pitch is less than 1:12. See §151(f)3C and in Section 3.2.3 of the Residential Manual.
- 2) Enter values in this column from either NFRC Certified Label or from Standards Default Table 116-A.
- 3) Indicate source either from NFRC or Table 116-A,
- 4) Enter values in this column from NFRC or from Standards Default Table 116B or adjusted SHGC from WS-3R.
- 5) Indicate source either from NFRC, Table 116B or WS-3R
- 6) Shading Devices are defined in Table 3-3 in the Residential Manual and see WS-3R to calculate Exterior Shading devices.
- 7) See Section 3.2.4 in the Residential Manual.

**HVAC SYSTEMS**

Heating Equipment Type and Capacity (furnace, heat pump, boiler, etc.)	Minimum Efficiency (AFUE or HSPF)	Distribution Type and Location (ducts, attic, etc.)	Duct or Piping R-Value	Thermostat Type	Configuration (split or package)

Cooling Equipment Type and Capacity (A/C, heat pump, evap. cooling)	Minimum Efficiency (SEER or EER)	Distribution Type and Location (ducts, attic, etc.)	Duct or Piping R-Value	Thermostat Type	Configuration (split or package)

**CERTIFICATE OF COMPLIANCE: RESIDENTIAL (Page 3 of 5) CF-1R**

Project Title

Date

**SEALED DUCTS and TXVs (or Alternative Measures)**

A signed CF-4R Form must be provided to the building department for each home for which the following are required.

<input checked="" type="checkbox"/>	
<input type="checkbox"/>	Sealed Ducts (all climate zones) (Installer testing and certification and HERS rater field verification required.)
<input type="checkbox"/>	TXVs, readily accessible (climate zones 2 and 8-15 only) (Installer testing and certification and HERS Rater field verification required.)
<input type="checkbox"/>	Refrigerant Charge (climate zones 2 and 8-15 only) (Installer testing and certification and HERS Rater field verification required.)

**OR**

<input type="checkbox"/>	Alternative to Sealed Ducts and Refrigerant Charge /TXVs (See Package D Alternative Package Features for Project Climate Zone in the RM Appendix B Table 151-C, Footnotes 7-14.
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**OR**

<input type="checkbox"/>	No ducts installed.
<input type="checkbox"/>	New ducts from existing space conditioning equipment, not exceeding 40ft. in length.
<input type="checkbox"/>	For additions and alterations, duct systems that are not documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Residential ACM Manual. Duct systems with more than 40 linear feet in unconditioned spaces shall meet the requirements of Section 150(m) and duct insulation requirements of Package D.

**WATER HEATING SYSTEMS**

<input checked="" type="checkbox"/>	
<input type="checkbox"/>	Check box if system meets criteria of a "Standard" system. Standard system is one gas-fired water heater per dwelling unit. If the water heater is a storage type, 50 gallons is the maximum capacity and recirculation system is not allowed.
<input type="checkbox"/>	Check box when using Preapproved Alternative Water Heating table, Table 5-4 in Chapter 5 in the Residential Manual. No water heating calculations are required, and the system complies automatically.
<input type="checkbox"/>	Check box if system does not meet criteria of "Standard" system, and does not comply with the Preapproved Alternative Water Heating table. In this case, the Performance Method must be used and must be included in the submittal.
<input type="checkbox"/>	Check box to verify that a time control is required for a recirculating system pump for a system serving multiple units

**Systems serving single dwelling units** (See RM Table 5-4, Alternative Water Heating Systems for recirculation requirements)

Water Heater Type/Fuel Type	Distribution Type	Number in System	Rated Input <sup>1</sup> (kW or Btu/hr)	Tank Capacity (gallons)	Energy Factor <sup>1</sup> or Thermal Efficiency	Standby <sup>1</sup> Loss (%)	Tank External Insulation R-Value

**System serving multiple dwelling units** (See Residential Manual Section 5.3.3)

Water Heater Type	Distribution Type	Number in System	Rated Input <sup>1</sup> (kW or Btu/hr)	Tank Capacity (gallons)	Energy Factor <sup>1</sup> or Thermal Efficiency	Standby <sup>1</sup> Loss (%)	Tank External Insulation R-Value

- 1) For small gas storage water heaters (rated inputs of less than or equal to 75,000 Btu/hr), electric resistance, and heat pump water heaters, list Energy Factor. For large gas storage water heaters (rated input of greater than 75,000 Btu/hr), list Rated Input, Recovery Efficiency, Thermal Efficiency and Standby Loss. For instantaneous gas water heaters, list Rated Input and Thermal Efficiencies.

**Pipe Insulation** (kitchen lines  $\geq 3/4$  inches) All hot water pipes from the heating source to the kitchen fixtures that are  $3/4$  inches or greater in diameter shall be thermally insulated as specified by Section 150 (j) 2 A or 150 (j) 2 B.

**CERTIFICATE OF COMPLIANCE: RESIDENTIAL****(Page 4 of 5)****CF-1R***Project Title**Date***SPECIAL FEATURES REQUIRING BUILDING OFFICIAL or HERS RATER VERIFICATION**

Indicate which special features are parts of this project. The list below only represents special features relevant to the prescriptive method.  
(Check Applicable boxes)

Category	Building Official Verification of Special Features	HERS Rater Verification	HERS Rater Diagnostic Testing	Measure
<b>Ducts</b>				
<input type="checkbox"/>	Y			100% of ducts in crawlspace/basement
<input type="checkbox"/>		Y		Buried ducts
<input type="checkbox"/>		Y		Diagnostic supply duct location, surface area, and R-value
<input type="checkbox"/>	Y			Duct increased R-value
<input type="checkbox"/>			Y	Duct leakage
<input type="checkbox"/>	Y			Ducts in attic with radiant barriers
<input type="checkbox"/>		Y		Less than 12 ft. of duct outside conditioned space
<input type="checkbox"/>		Y		Non-standard duct location
<input type="checkbox"/>	Y			Supply registers within two ft of floor
<input type="checkbox"/>				
<b>Envelope</b>				
<input type="checkbox"/>	Y			Air retarding wrap
<input type="checkbox"/>	Y			Cool roof
<input type="checkbox"/>	Y			Exterior shades
<input type="checkbox"/>	Y			High thermal mass
<input type="checkbox"/>	Y			Inter-zone ventilation
<input type="checkbox"/>	Y			Metal framed walls
<input type="checkbox"/>	Y			Non-default vent heights
<input type="checkbox"/>		Y		Quality insulation installation
<input type="checkbox"/>	Y			Radiant barrier
<input type="checkbox"/>			Y	Reduced infiltration (blower door). May also require mechanical ventilation.
<input type="checkbox"/>	Y			Solar gain targeting (for sunspaces)
<input type="checkbox"/>	Y			Sunspace with interzone surfaces
<input type="checkbox"/>	Y			Vent area greater than 10%
<input type="checkbox"/>				
<b>HVAC Equipment</b>				
<input type="checkbox"/>			Y	Adequate air flow
<input type="checkbox"/>		Y		Air conditioner size
<input type="checkbox"/>			Y	Air handler fan power
<input type="checkbox"/>		Y		High EER
<input type="checkbox"/>	Y			Hydronic heating systems
<input type="checkbox"/>		Y		Mechanical ventilation
<input type="checkbox"/>			Y	Refrigerant charge
<input type="checkbox"/>		Y		Thermostatic expansion valve (TXV)
<input type="checkbox"/>	Y			Zonal control
<b>Water Heater</b>				
<input type="checkbox"/>	Y			Combined hydronic
<input type="checkbox"/>	Y			High EF for existing water heaters
<input type="checkbox"/>	Y			Non-NAECA water heater
<input type="checkbox"/>	Y			Non-standard water heaters (wh/unit)
<input type="checkbox"/>	Y			Water heater distribution credits

<b>CERTIFICATE OF COMPLIANCE: RESIDENTIAL</b>		<b>(Page 5 of 5)</b>	<b>CF-1R</b>
Project Title		Date	

**Special Remarks**


**COMPLIANCE STATEMENT**

This certificate of compliance lists the building features and specifications needed to comply with Title 24, Parts 1 and 6 of the California Code of Regulations, and the administrative regulations to implement them. This certificate has been signed by the individual with overall design responsibility. The undersigned recognizes that compliance using duct design, duct sealing, verification of refrigerant charge and TXVs, insulation installation quality, and building envelope sealing require installer testing and certification and field verification by an approved HERS rater.

**Designer or Owner** (per Business and Professions Code)

**Documentation Author**

Name:	Name:
Title/Firm:	Title/Firm:
Address:	Address:
Telephone:	Telephone:
License #:	License #: (if applicable)
(signature) (date)	(signature) (date)

**Enforcement Agency**

Name: _____ Title _____ Agency: _____ Telephone: _____ _____ (signature / stamp) (date)	Comments: _____ _____ _____ _____ _____ _____
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**MANDATORY MEASURES SUMMARY: RESIDENTIAL (Page 1 of 2) MF-1R**

Project Title

Date

Note: Low-rise residential buildings subject to the Standards must contain these measures regardless of the compliance approach used. More stringent compliance requirements from the Certificate of Compliance supersede the items marked with an asterisk (\*) below. When this checklist is incorporated into the permit documents, the features noted shall be considered by all parties as minimum component performance specifications for the mandatory measures whether they are shown elsewhere in the documents or on this checklist only.

**Instructions:** Check or initial applicable boxes or check NA if not applicable and included with the permit application documentation.

DESCRIPTION	NA	Designer	Enforce -ment
<b>Building Envelope Measures:</b>	✓	✓	✓
* §150(a): Minimum R-19 in wood frame ceiling insulation or equivalent U-factor in metal frame ceiling.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(b): Loose fill insulation manufacturer's labeled R-Value: _____.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
* §150(c): Minimum R-13 wall insulation in wood framed walls or equivalent U-factor in metal frame walls (does not apply to exterior mass walls).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
* §150(d): Minimum R-13 raised floor insulation in framed floors or equivalent U-factor.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(e): Installation of Fireplaces, Decorative Gas Appliances and Gas Logs.			
1. Masonry and factory-built fireplaces have:			
a. closeable metal or glass door covering the entire opening of the firebox	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. outside air intake with damper and control, flue damper and control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. No continuous burning gas pilot lights allowed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(f): Air retarding wrap installed to comply with §151 meets requirements specified in the ACM Residential Manual.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(g): Vapor barriers mandatory in Climate Zones 14 and 16 only.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(l): Slab edge insulation - water absorption rate for the insulation material alone without facings no greater than 0.3%, water vapor permeance rate no greater than 2.0 perm/inch.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§118: Insulation specified or installed meets insulation installation quality standards. Indicate type and include CF-6R Form: _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§116-§117: Fenestration Products, Exterior Doors, and Infiltration/Exfiltration Controls.			
1. Doors and windows between conditioned and unconditioned spaces designed to limit air leakage.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Fenestration products (except field-fabricated) have label with certified U-factor, certified Solar Heat Gain Coefficient (SHGC), and infiltration certification.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Exterior doors and windows weather-stripped; all joints and penetrations caulked and sealed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Space Conditioning, Water Heating and Plumbing System Measures:</b>			
§110-§113: HVAC equipment, water heaters, showerheads and faucets certified by the Energy Commission.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(h): Heating and/or cooling loads calculated in accordance with ASHRAE, SMACNA or ACCA.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(i): Setback thermostat on all applicable heating and/or cooling systems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(j): Water system pipe and tank insulation and cooling systems line insulation.			
1. Storage gas water heaters rated with an Energy Factor less than 0.58 must be externally wrapped with insulation having an installed thermal resistance of R-12 or greater.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Back-up tanks for solar system, unfired storage tanks, or other indirect hot water tanks have R-12 external insulation or R-16 internal insulation and indicated on the exterior of the tank showing the R-value.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The following piping is insulated according to Table 150-A/B or Equation 150-A Insulation Thickness:			
1. First 5 feet of hot and cold water pipes closest to water heater tank, non-recirculating systems, and entire length of recirculating sections of hot water pipes shall be insulated to Table 150B.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Cooling system piping (suction, chilled water, or brine lines), piping insulated between heating source and indirect hot water tank shall be insulated to Table 150-B and Equation 150-A.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Steam hydronic heating systems or hot water systems >15 psi, meet requirements of Table 123-A.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



# MANDATORY MEASURES SUMMARY: RESIDENTIAL (Page 2 of 2)

MF-1R

DESCRIPTION	NA	Designer	Enforcement
<b>Space Conditioning, Water Heating and Plumbing System Measures: (continued)</b>	✓	✓	✓
5. Insulation must be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Insulation for chilled water piping and refrigerant suction piping includes a vapor retardant or is enclosed entirely in conditioned space.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Solar water-heating systems/collectors are certified by the Solar Rating and Certification Corporation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
* §150(m): Ducts and Fans			
1. All ducts and plenums installed, sealed and insulated to meet the requirement of the CMC Sections 601, 602, 603, 604, 605 and Standard 6-5; supply-air and return-air ducts and plenums are insulated to a minimum installed level of R-4.2 or enclosed entirely in conditioned space. Openings shall be sealed with mastic, tape or other duct-closure system that meets the applicable requirements of UL 181, UL 181A, or UL 181B or aerosol sealant that meets the requirements of UL 723. If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape shall be used.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Building cavities, support platforms for air handlers, and plenums defined or constructed with materials other than sealed sheet metal, duct board or flexible duct shall not be used for conveying conditioned air. Building cavities and support platforms may contain ducts. Ducts installed in cavities and support platforms shall not be compressed to cause reductions in the cross-sectional area of the ducts.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and draw bands.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Exhaust fan systems have back draft or automatic dampers.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Gravity ventilating systems serving conditioned space have either automatic or readily accessible, manually operated dampers.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Protection of Insulation. Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Flexible ducts cannot have porous inner cores.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§114: Pool and Spa Heating Systems and Equipment.			
1. A thermal efficiency that complies with the Appliance Efficiency Regulations, on-off switch mounted outside of the heater, weatherproof operating instructions, no electric resistance heating and no pilot light.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. System is installed with:			
a. at least 36" of pipe between filter and heater for future solar heating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. cover for outdoor pools or outdoor spas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Pool system has directional inlets and a circulation pump time switch.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§115: Gas fired fan-type central furnaces, pool heaters, spa heaters or household cooking appliances have no continuously burning pilot light. (Exception: Non-electrical cooking appliances with pilot < 150 Btu/hr)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§118(i): Cool Roof material meets specified criteria	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Residential Lighting Measures:</b>			
§150(k)1: HIGH EFFICACY LUMINAIRES OTHER THAN OUTDOOR HID: contain only high efficacy lamps as outlined in Table 150-C, and do not contain a medium screw base socket (E24/E26). Ballast for lamps 13 watts or greater are electronic and have an output frequency no less than 20 kHz	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(k)1: HIGH EFFICACY LUMINAIRES - OUTDOOR HID: contain only high efficacy lamps as outlined in Table 150-C, luminaire has factory installed HID ballast	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(k)2: Permanently installed luminaires in kitchens shall be high efficacy luminaires. Up to 50 percent of the wattage, as determined in § 130 (c), of permanently installed luminaires in kitchens may be in luminaires that are not high efficacy luminaires, provided that these luminaires are controlled by switches separate from those controlling the high efficacy luminaires.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(k)3: Permanently installed luminaires in bathrooms, garages, laundry rooms and utility rooms shall be high efficacy luminaires. OR are controlled by an occupant sensor(s) certified to comply with Section 119(d) that does not turn on automatically or have an always on option.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(k)4: Permanently installed luminaires located other than in kitchens, bathrooms, garages, laundry rooms, and utility rooms shall be high efficacy luminaires (except closets less than 70ft²): OR are controlled by a dimmer switch OR are controlled by an occupant sensor that complies with Section 119(d) that does not turn on automatically or have an always on option.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(k)5: Luminaires that are recessed into insulated ceilings are approved for zero clearance insulation cover (IC) and are certified airtight to ASTM E283 and labeled as air tight (AT) to less than 2.0 CFM at 75 Pascals.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(k)6: Luminaires providing outdoor lighting and permanently mounted to a residential building or to other buildings on the same lot shall be high efficacy luminaires (not including lighting around swimming pools/water features or other Article 680 locations) OR are controlled by occupant sensors with integral photo control certified to comply with Section 119(d).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(k)7: Lighting for parking lots for 8 or more vehicles shall have lighting that complies with Sec. 130, 132, and 147. Lighting for parking garages for 8 or more vehicles shall have lighting that complies with Sec. 130, 131, and 146.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§150(k)8: Permanently installed lighting in the enclosed, non-dwelling spaces of low-rise residential buildings with four or more dwelling units shall be high efficacy luminaires OR are controlled by occupant sensor(s) certified to comply with Section 119(d).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# FENESTRATION – MAXIMUM ALLOWED AREA WORKSHEET

WS-4R

Project Title

Date

## FENESTRATION PRODUCTS – NEW CONSTRUCTION- NEW BUILDINGS

Use this table for new building construction to account for total building % of fenestration.

A	B	C	D	E	F	G
#/Type/Pos. (Front, Left, Rear, Right, Skylight)	Orientation	Total Fenestration, West Facing Area (ft <sup>2</sup> )	Total Fenestration for N, S, E Orientations Area (ft <sup>2</sup> )	CFA (ft <sup>2</sup> )	Total Percent of West Facing Fenestration <sup>1</sup> (C/E) x 100%	Total % of Fenestration <sup>2</sup> Including West (D/E) x 100% + F
	North					
	South					
	East					
	West					
	Totals					

1) If west facing area exceeds 5% of CFA in climate zones 2, 4, and 7-15, the performance approach must be used.

2) If total percent of fenestration exceeds 20% including West facing orientations then performance approach must be used. West facing area includes skylights tilted to the west or tilted in any direction when the pitch is less than 1:12 for Package D only.

## FENESTRATION PRODUCTS – NEW CONSTRUCTION- ADDITIONS

✓ ☐ Less than 100 ft<sup>2</sup>, ☐ Less than or Equal to 1000 ft<sup>2</sup>, ☐ Greater 1000 ft<sup>2</sup>

A	B	C	D	E	F	G	H
#/Type/Pos. (Front, Left, Rear, Right, Skylight)	Orienta- tion	Proposed Addition's CFA <sup>1, 2, 3</sup>	Proposed Addition's Fenestration Area (ft <sup>2</sup> ) <sup>4</sup>	Fenestration Area Removed to make way for Addition (ft <sup>2</sup> ) <sup>2</sup>	Total Area Added Fenestration <sup>2</sup> (D - E)	Total % of West Facing Fenestration <sup>2</sup> (G/C) x 100%	Total % of Fenestra- tion <sup>2, 3, 4</sup> (F/C) x 100%
	North						
	South						
	East						
	West <sup>4</sup>						
	Total						

1) Additions ≤100 sf are allowed to install up to 50ft<sup>2</sup> of fenestration and are exempt from the 5% west facing and 20% maximum total area limits and shall meet the U-factor and SHGC requirements of Package D. See Table 8-2 in the Residential Manual. Note: Leave columns E, F, G, H, and I blank.

2) Additions ≤1,000 ft<sup>2</sup>, the maximum net allowed fenestration is 20% and may be increased additionally to by the amount of glazing removed in the wall that separates the addition from the existing house. However, the total West facing fenestration can not exceed 5% of the proposed addition's CFA including skylights orientated in any direction and tilted with a pitch of < 1:12. Column G can not exceed 5% and Column H can not exceed 20%.

3) Additions >1,000 ft<sup>2</sup>, must meet Package D requirements. See Table 8-2 and Table 151-C in Appendix B of the RM or use Performance Approach.

4) The 5%west orientation restrictions are only for Climate zones 2, 4, and 7-15; for Climate Zones 2, 4 and 7-15 enter **zero** (0) in column E.

## FENESTRATION PRODUCTS: ALTERATIONS

Use this table for alterations to an existing building where fenestrations products (windows) are being removed and/or added.

A	B	C	D	E	F	G	H	I
Existing CFA (ft <sup>2</sup> )	Existing Orientation	Existing Area (ft <sup>2</sup> )	Removed Orientation	Removed Area (ft <sup>2</sup> )	Proposed Installed Orientation	Proposed Installed New Area (ft <sup>2</sup> )	Total Net Fenestration (ft <sup>2</sup> ) (C-E+G)	Total % of Fenestra-tion <sup>1, 2</sup> (H/A) x 100% Max of 20%
	North		North		North			
	South		South		South			
	East		East		East			
	West		West		West			
	Total		Total		Total			

1) When 50 ft<sup>2</sup> or more of fenestration area is added to an existing building, then the fenestration must meet the requirements of Package D.

2) The area requirement for the total fenestration area for the whole building, including the added fenestration, must not exceed 20%. Otherwise, the Performance Approach must be used. See Section 8.3.3 in the RM for further details.

**RESIDENTIAL KITCHEN LIGHTING WORKSHEET****WS-5R**

Project Title \_\_\_\_\_

Date \_\_\_\_\_

At least 50% of the total rated wattage of permanently installed luminaires in the kitchen must be in luminaires that are high efficacy luminaires as defined in Table 150-C. Luminaires that are not high efficacy must be switched separately.

**Kitchen Lighting Schedule.** Provide the following information for all luminaires to be installed in kitchens.

Luminaire Type	High Efficacy?	Watts	x	Quantity	=	High Efficacy Watts	or	Other Watts
_____	Yes <input type="checkbox"/> No <input type="checkbox"/>	_____	x	_____	=	_____	or	_____
_____	Yes <input type="checkbox"/> No <input type="checkbox"/>	_____	x	_____	=	_____	or	_____
_____	Yes <input type="checkbox"/> No <input type="checkbox"/>	_____	x	_____	=	_____	or	_____
_____	Yes <input type="checkbox"/> No <input type="checkbox"/>	_____	x	_____	=	_____	or	_____
_____	Yes <input type="checkbox"/> No <input type="checkbox"/>	_____	x	_____	=	_____	or	_____
Total: A:						B:		
<b>COMPLIES IF <math>A \geq B</math></b>								Yes <input type="checkbox"/> No <input type="checkbox"/>

**Rules for Determining Residential Kitchen Luminaire Wattage****Screw Base Sockets §130(c) 1**

(Not containing permanently installed ballasts) The maximum relamping rated wattage of the luminaire, as listed on a permanent factory-installed label (luminaire wattage is not based on type or wattage of lamp that is used).

**Permanently or Remotely Installed Ballasts §130(c) 2**

The operating input wattage of the rated lamp/ballast combination based on values published in manufacturer's catalogs based on independent testing lab reports.

**Line Voltage Track Lighting (90 through 480 volts) §130(c) 3**

1. Volt-ampere (VA) rating of the branch circuit(s) feeding the tracks; or
2. For tracks equipped with an integral current limiter, the higher of;
  - The wattage (or VA) rating of an approved integral current limiter controlling the track system or
  - 15 watts per linear foot of the track; or
3. For tracks without an integral current limiter, the higher of;
  - 45 W per linear foot of the track or
  - The total wattage of all of the luminaires included in the system.

**Low Voltage Track Lighting (less than 90 volts) §130(c) 4**

Rated wattage of the transformer feeding the system, as shown on a permanent factory-installed label

**Other Lighting §130(c) 5**

(Lighting systems that are not addressed in §130 (c) 1-4) The maximum rated wattage, or operating input wattage of the system, listed on a permanent factory installed label, or published in manufacturer's catalogs, based on independent testing lab reports.

*EXAMPLE***RESIDENTIAL KITCHEN LIGHTING WORKSHEET****WS-5R**

Project Title \_\_\_\_\_

Date \_\_\_\_\_

**Kitchen Lighting Schedule.** Provide the following information for all luminaires to be installed in kitchens.

Luminaire Type	High Efficacy (y/n)	Watts	x	Quantity	=	High Efficacy Watts	or	Other Watts
CFL-1	Yes	26	x	5	=	130	or	_____
MR-16	No	55	x	2	=	_____	or	110
_____	_____	_____	x	_____	=	_____	or	_____
_____	_____	_____	x	_____	=	_____	or	_____
_____	_____	_____	x	_____	=	_____	or	_____
Total: A:						B:		
<b>COMPLIES IF <math>A \geq B</math></b>								Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>

## SECTION 116 – MANDATORY REQUIREMENTS FOR FENESTRATION PRODUCTS AND EXTERIOR DOORS

- (a) **Certification of Fenestration Products and Exterior Doors other than Field-fabricated.** Any fenestration product and exterior door, other than field-fabricated fenestration products and field-fabricated exterior doors, may be installed only if the manufacturer has certified to the commission, or if an independent certifying organization approved by the commission has certified, that the product complies with all of the applicable requirements of this subsection.

1. **Air leakage.** Manufactured fenestration products and exterior doors shall have air infiltration rates not exceeding 0.3 cfm/ft.<sup>2</sup> of window area, 0.3 cfm/ft.<sup>2</sup> of door area for residential doors, 0.3 cfm/ft.<sup>2</sup> of door area for nonresidential single doors (swinging and sliding), and 1.0 cfm/ft.<sup>2</sup> for nonresidential double doors (swinging), when tested according to NFRC-400 or ASTM E 283 at a pressure differential of 75 pascals or 1.57 pounds/ft.<sup>2</sup>, incorporated herein by reference.
2. **U-factor.** A fenestration product's U-factor shall be rated in accordance with NFRC 100, or the applicable default U-factor set forth in TABLE 116-A.

**EXCEPTION to Section 116 (a) 2:** If the fenestration product is site-built fenestration in a building covered by the nonresidential standards with less than 10,000 square feet of site-built fenestration or is a skylight, the default U-factor may be the applicable U-factor as set forth in the Nonresidential ACM Manual.

3. **SHGC.** A fenestration product's SHGC shall be rated in accordance with NFRC 200, or NFRC 100 for site-built fenestration, or the applicable default SHGC set forth in TABLE 116-B.

**EXCEPTION to Section 116 (a) 3:** If the fenestration product is site-built fenestration in a building covered by the nonresidential standards with less than 10,000 square feet of site-built fenestration or is a skylight, the default SHGC may be calculated according to Equation 116-A.

### EQUATION 116-A DEFAULT SHGC CALCULATION (SUBJECT TO ABOVE EXCEPTION)

$$SHGC_{fen} = 0.08 + 0.86 \times SHGC_c$$

#### WHERE

- SHGC<sub>fen</sub> = The solar heat gain coefficient for the fenestration including glass and frame.
- SHGC<sub>c</sub> = The center of glass solar heat gain coefficient for the glass alone as documented in the glazing manufacturer's literature. Documentation shall be provided as specified in the Nonresidential ACM Manual.

4. **Labeling.** Fenestration products shall:
  - A. Have a temporary label (or label certificate for site-built fenestration) meeting the requirements of Section 10-111 (a) 1, not to be removed before inspection by the enforcement agency, listing the certified U-factor and SHGC, and certifying that the air leakage requirements of Section 116 (a) 1 are met for each product line; and
  - B. Have a permanent label (or label certificate for site-built fenestration) meeting the requirements of Section 10-111 (a) 2 if the product is rated using NFRC procedures.

**EXCEPTION to Section 116 (a):** Fenestration products removed and reinstalled as part of a building alteration or addition.

- (b) **Installation of Field-fabricated Fenestration and Exterior Doors.** Field-fabricated fenestration and field-fabricated exterior doors may be installed only if the compliance documentation has demonstrated compliance for the installation using U-factors from TABLE 116-A and SHGC values from TABLE 116-B. Field-fabricated fenestration and field-fabricated exterior doors shall be caulked between the fenestration products or exterior door and the building, and shall be weatherstripped. Buildings with 10,000 or more square feet of vertical glazing shall have no more than 1,000 square feet of field-fabricated fenestration.

**EXCEPTION to Section 116 (b):** Unframed glass doors and fire doors need not be weatherstripped or caulked.

TABLE 116-A DEFAULT FENESTRATION PRODUCT U-FACTORS

FRAME TYPE <sup>1</sup>	PRODUCT TYPE	SINGLE PANE U-FACTOR	DOUBLE PANE U-FACTOR <sup>2</sup>
Metal	Operable	1.28	0.79
Metal	Fixed	1.19	0.71
Metal	Greenhouse/garden window	2.26	1.40
Metal	Doors	1.25	0.77
Metal	Skylight	1.98	1.3
Metal, Thermal Break	Operable	N.a	0.66
Metal, Thermal Break	Fixed	N.a	0.55
Metal, Thermal Break	Greenhouse/garden window	N.a	1.12
Metal, Thermal Break	Doors	N.a	0.59
Metal, Thermal Break	Skylight	N.a	1.11
Nonmetal	Operable	0.99	0.58
Nonmetal	Fixed	1.04	0.55
Nonmetal	Doors	0.99	0.53
Nonmetal	Greenhouse/garden windows	1.94	1.06
Nonmetal	Skylight	1.47	0.84

<sup>1</sup> Metal includes any field-fabricated product with metal cladding. Nonmetal-framed manufactured fenestration products with metal cladding must add 0.04 to the listed U-factor. Nonmetal frame types can include metal fasteners, hardware, and door thresholds. Thermal break product design characteristics are:

- The material used as the thermal break must have a thermal conductivity of not more than 3.6 Btu-inch/hr/ft<sup>2</sup>/°F,
- The thermal break must produce a gap of not less than 0.210 inch, and
- All metal members of the fenestration product exposed to interior and exterior air must incorporate a thermal break meeting the criteria in Items a. and b. above.

In addition, the fenestration product must be clearly labeled by the manufacturer that it qualifies as a thermally broken product in accordance with this standard. Thermal break values shall not apply to field-fabricated fenestration products.

<sup>2</sup>For all dual-glazed fenestration products, adjust the listed U-factors as follows:

- Subtract 0.05 for spacers of 7/16 inch or wider.
- Subtract 0.05 for products certified by the manufacturer as low-E glazing.
- Add 0.05 for products with dividers between panes if spacer is less than 7/16 inch wide.
- Add 0.05 to any product with true divided lite (dividers through the panes).

TABLE 116-B DEFAULT SOLAR HEAT GAIN COEFFICIENT

FRAME TYPE	PRODUCT	GLAZING	TOTAL WINDOW SHGC <sup>2</sup>	
			Single Pane	Double Pane
Metal	Operable	Clear	0.80	0.70
Metal	Fixed	Clear	0.83	0.73
Metal	Operable	Tinted	0.67	0.59
Metal	Fixed	Tinted	0.68	0.60
Metal, Thermal Break	Operable	Clear	N.a	0.63
Metal, Thermal Break	Fixed	Clear	N.a	0.69
Metal, Thermal Break	Operable	Tinted	N.a	0.53
Metal, Thermal Break	Fixed	Tinted	N.a	0.57
Nonmetal	Operable	Clear	0.74	0.65
Nonmetal	Fixed	Clear	0.76	0.67
Nonmetal	Operable	Tinted	0.60	0.53
Nonmetal	Fixed	Tinted	0.63	0.55

<sup>2</sup> SHGC = Solar Heat Gain Coefficient.

**SOLAR HEAT GAIN COEFFICIENT WORKSHEET (Page 1 of 2)****WS-3R**

Project Title

Date

Items 1 through 4 must be completed for glazing/shading combinations by using the Default Table for Fenestration Products (Table 116-B of the Standard), NFRC certified data, or Solar Heat Gain Coefficients Used for Exterior Shading Attachments (Table S-1 below) for the specific conditions indicated (#1a or #1b or #3).

**General Information**

1a. For Fenestration Products w/NFRC testing and labels:

SHGC<sub>fen</sub> = \_\_\_\_\_

OR

1b. For Fenestration Products without NFRC testing and labels (Table 116-B of the Standard): SHGC<sub>fen</sub> = \_\_\_\_\_

1c. Frame Type

1d. Product Type

1e. Glazing Type

1f. Single/Double Pane

metal, non-metal,  
metal w/thermal break

operable/fixed

(visibly) tinted  
clear (not visibly tinted)

single pane/double pane

2. Skylight

(Y/N) \_\_\_\_\_

(A skylight is fenestration mounted on a roof surface at a slope less than 60° from the horizon.)

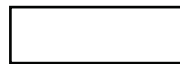
**Combined Exterior Shade with Fenestration**

Exterior Shade Type: \_\_\_\_\_

3. SHGC<sub>Exterior Shade</sub>: \_\_\_\_\_

(If no exterior shade, assume standard bug screens, SHGC<sub>Exterior Shade</sub> = 0.76 for ordinary windows. This requirement does not apply to skylights where SHGC<sub>Exterior Shade</sub> is assumed to be 1.00. If another exterior shade is substituted for bug screens, use one of the values from Table S-1.

4.  $\left[ \left( \frac{\text{SHGC}_{\text{max}}}{\text{SHGC}_{\text{max}}} \times 0.2875 \right) + 0.75 \right] \times \frac{\text{SHGC}_{\text{min}}}{\text{SHGC}_{\text{min}}} =$



Total SHGC

Where:

SHGC<sub>max</sub> = Larger of (#1a or #1b) or #3SHGC<sub>min</sub> = Smaller of (#1a or #1b) or #3

Note: Calculated Solar Heat Gain Coefficient values for Total SHGC may be used directly for prescriptive packages.

- Package C Target Value for Total SHGC is 0.38 for Climate Zones 2, 4, 7-15
- Package C Target Value for Total SHGC is 0.42 for Climate Zones 1, 3, 5, 6, 16
- Package D Target Value for Total SHGC is 0.40 for Climate Zones 2, 4, 7-15

Table S-1: Solar Heat Gain Coefficients Used for Exterior Shading  
Attachments for WS-3R and Computer Performance Methods<sup>1,2</sup>

Exterior Shading Device<sup>3</sup>w/Single Pane  
Clear Glass & Metal Framing<sup>4</sup>

- 1) Standard Bug Screens
- 2) Exterior Sunscreens with Weave 53\*16/inch
- 3) Louvered Sunscreens w/Louvers as Wide as Openings
- 4) Low Sun Angle (LSA) Louvered Sunscreens
- 5) Roll-down Awning
- 6) Roll Down Blinds or Slats
- 7) None (for skylights only)

0.76  
0.30  
0.27  
0.13  
0.13  
0.13  
1.00

1. These values may be used on line 3 of the Solar Heat Gain Coefficient (SHGC) Worksheet (WS-3R) to calculate exterior shading with other glazing types and combined interior and exterior shading with glazing.
2. Exterior operable awnings (canvas, plastic or metal), except those that roll vertically down and cover the entire window, should be treated as overhangs for purposes of compliance with the Standards.
3. Standard bug screens must be assumed for all fenestration unless replaced by other exterior shading attachments. The solar heat gain coefficient listed for bug screens is an area-weighted value that assumes that the screens are only on operable windows. The solar heat gain coefficient of any other exterior shade screens applied only to some window areas must be area-weighted with the solar heat gain coefficient of standard bug screens for all other glazing (see Form WS-2R). Different shading conditions may also be modeled explicitly in the computer performance method.
4. Reference glass for determining solar heat gain coefficients is 1/8 inch double strength (DSS) glass.

**Instructions for WS-3R**

The following explains how to calculate solar heat gain coefficients on WS-3R. The number of each item below corresponds to the appropriate item on WS-3R.

Enter either:

- 1a. For products with NFRC testing and labels, enter the product's labeled SHGC as #1a.  $SHGC_{fen}$

OR

- 1b. Enter the default  $SHGC_{fen}$  from Table 116-B of the Standards corresponding to the fenestration characteristics described in entries 1c, 1d, 1e, and 1f. Entries for 1c, 1d, 1e, and 1f are only needed if 1b is entered for  $SHGC_{fen}$ .

If 1b is entered, then:

- 1c Describe the Frame Type [metal, metal w/thermal break, or non-metal (non-metal includes both vinyl and wood)].
- 1d The Product Type (operable or fixed);
- 1e The glazing type (tinted or uncoated). Note that tints or coatings that cannot be easily observed by the building official must be classified as "uncoated;" that is, tints must be easily visible to the naked eye.
- 1f Single or double pane glazing.
- 2 For skylights mounted on a roof surface, enter "Y," otherwise enter "N." A skylight is fenestration mounted at a slope less than 60° from the horizon.

In a performance compliance, select *standard* or *draperies*. This is the only available choice and some compliance tools will eliminate this choice altogether.

- 3 Describe the exterior shading device in the space provided (e.g., roll down awning). List  $SHGC_{Exterior\ Shade}$ , the SHGC of the exterior shade with 1/8" clear single pane glass and metal framing, from Table S-1. If a single window or skylight has multiple exterior shades (i.e., shade screens and awnings) use the one shading device with the lower SHGC.

If no exterior shade is proposed, assume standard bug screens with a SHGC of 0.76 (or a SHGC of 1.00 for horizontal glazing). This applies to the full area of fixed fenestration products as well as operable.

- 4 Calculate  $SHGC_{Shade\ Open}$  using values from Items 3 and either 1a or 1b. The result is the combined SHGC of the fenestration product and exterior device with the interior *shade open*.



## The NFRC Label

The **National Fenestration Rating Council (NFRC)** energy performance label can help you determine how well a product will perform the functions of helping to cool your building in the summer, warm your building in the winter, keep out wind, and resist condensation. By using the information contained on the label, builders and consumers can reliably compare one product with another, and make informed decisions about the windows, doors, and skylights they buy.

NFRC adopted a new energy performance label in 2005. It lists the manufacturer, describes the product, provides a source for additional information, and includes ratings for one or more energy performance characteristics.

The information contained on the label is also available in the NFRC's online [Certified Products Directory](#).

### U-Factor

U-factor measures how well a product prevents heat from escaping. The rate of heat loss is indicated in terms of the U-factor (U-value) of a window assembly. U-Factor ratings generally fall between 0.20 and 1.20. The insulating value is indicated by the R-value which is the inverse of the U-value. The lower the U-value, the greater a window's resistance to heat flow and the better its insulating value.

### Solar Heat Gain Coefficient

Solar Heat Gain Coefficient (SHGC) measures how well a product blocks heat caused by sunlight. The SHGC is the fraction of incident solar radiation admitted through a window, both admitted through a window, both directly transmitted, and absorbed and subsequently released inward. SHGC is expressed as a number between 0 and 1. The lower a window's solar heat gain coefficient, the less solar heat it transmits.

### Visible Transmittance

Visible Transmittance (VT) measures how much light comes through a product. The visible transmittance is an optical property that indicates the amount of visible light transmitted. VT is expressed as a number between 0 and 1. The higher the VT, the more light is transmitted.

### Air Leakage\*

Air Leakage (AL) is indicated by an air leakage rating expressed as the equivalent cubic feet of air passing through a square foot of window area (cfm/sq ft). Heat loss and gain occur by infiltration through cracks in the window assembly. The lower the AL, the less air will pass through cracks in the window assembly.

### Condensation Resistance\*

Condensation Resistance (CR) measures the ability of a product to resist the formation of condensation on the interior surface of that product. The higher the CR rating, the better that product is at resisting condensation formation. While this rating cannot predict condensation, it can provide a credible method of comparing the potential of various products for condensation formation. CR is expressed as a number between 0 and 100.

*\* This rating is optional and manufacturers can choose not to include it.*

 National Fenestration Rating Council® <b>CERTIFIED</b>	<b>World's Best Window Co.</b>  Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: <b>Vertical Slider</b>
<b>ENERGY PERFORMANCE RATINGS</b>	
U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
<b>0.35</b>	<b>0.32</b>
<b>ADDITIONAL PERFORMANCE RATINGS</b>	
Visible Transmittance	Air Leakage (U.S./I-P)
<b>0.51</b>	<b>0.2</b>
Condensation Resistance	
<b>51</b>	<b>—</b>
<small>Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information. <a href="http://www.nfrc.org">www.nfrc.org</a></small>	



## **PRESCRIPTIVE REQUIREMENTS FOR WATER HEATERS**

*Table 5-1 – System Component Descriptions: Distribution Systems within a Dwelling Unit*

Distribution Systems	Description
Standard (STD)	Standard system without any pumps for distributing hot water. The first 5 ft of pipes from the storage tank is insulated for both hot and cold water pipes. Pipes from the water heater to the kitchen that are 0.75 in. or larger are insulated. Pipe insulation is required per §150(j).
Point of Use (POU)	System with no more than 8 ft horizontal distance between the water heater and hot water fixtures, except laundry.
Pipe Insulation (PIA)	All hot water pipes are insulated per the requirements of §150(j).
Standard Pipes with No Insulation (SNI)	Standard system, but without insulation on the pipes to the kitchen.
Parallel Piping (PP)	Individual pipes radiate from a manifold on the water heater to each of the fixtures.
Recirculation No Control (RNC)	Distribution system using a pump to recirculate hot water to branch piping through a looped hot water main. Pump operation and water flow are continuous. Pipe insulation is required per §150(j).
Recirculation with Temperature Control (RTmp)	Recirculation system that uses temperature controls to cycle pump operation to maintain recirculated water temperatures within certain limits. Pipe insulation is required per §150(j).
Recirculation with Timer Control (RTm)	Recirculation system that uses a timer control to cycle pump operation based on time of day. Pipe insulation is required per §150(j).
Recirculation with Timer and Temperature Control (RTmTmp)	Recirculation system that uses both temperature and timer controls to regulate pump operation. Pipe insulation is required per §150(j).
Recirculation with Demand Control (RDmd)	Recirculation system that uses brief pump operation to recirculate hot water to fixtures just prior to hot water use when a demand for hot water is indicated. Pipe insulation is required per §150(j).

*Table 5-4 – Preapproved Alternative Water Heating Systems for Single Dwelling Units (Equivalent to prescriptive requirement)*

System type	System Approved
Multiple (more than one) Instantaneous gas or propane with no pilot light and an energy factor of 0.85 or greater	YES
Heat pump water heater of 50 gallons or less with an energy factor of 2.5 or greater with a solar system contributing at least 25% of the total water heating requirements	YES
Two 50 gallon or less storage gas or propane fired units each with energy factor of 0.67 or greater and pipe insulation	YES
Storage gas of 50 gallons or less with an energy factor of 0.59 or greater with Parallel Piping	YES
Storage Gas of 50 gallons or less with an energy factor of 0.62 or greater with Demand Recirculation	YES
Storage Gas of 50 gallons or less with an energy factor of 0.58 or greater with time and temperature recirculation control and a solar system contributing at least 25% of the total water heating energy use	YES
50 Gal Electric with an energy factor of 0.94 or greater, pipe insulation and solar with at least a 60% solar fraction.	YES (only in areas where natural gas is not available)
Water Heater heat pump of 50 gallons or less with an energy factor of 2.5 or greater and pipe insulation	YES (only in areas where natural gas is not available)

## Appendix D

### *Eligibility Criteria for Radiant Barriers*

Radiant barriers shall meet specific eligibility and installation criteria to be modeled by any ACM and receive energy credit for compliance with the energy efficiency standards for low-rise residential buildings.

- The emittance of the radiant barrier shall be less than or equal to 0.05 as tested in accordance with ASTM C-1371 or ASTM E-408.
- Installation shall conform to ASTM C-1158 [Standard Practice For Use and Installation Of Radiant Barrier Systems (RBS) In Building Construction.], ASTM C-727 (Standard Practice For Installation and Use Of Reflective Insulation In Building Constructions.), ASTM C-1313 (Standard Specification for Sheet Radiant Barriers for Building Construction Applications), and ASTM C-1224 (Standard Specification for Reflective Insulation for Building Applications). The radiant barrier shall be securely installed in a permanent manner with the shiny side facing down toward the interior of the building (ceiling or attic floor). Moreover, radiant barriers shall be installed at the top chords of the roof truss/rafters in *any* of the following methods:
  1. Draped over the truss/rafter (the top chords) before the upper roof decking is installed.
  2. Spanning between the truss/rafters (top chords) and secured (stapled) to each side.
  3. Secured (stapled) to the bottom surface of the truss/rafter (top chord). A minimum air space shall be maintained between the top surface of the radiant barrier and roof decking of not less than 1.5 inches at the center of the truss/rafter span.
  4. Attached [laminated] directly to the underside of the roof decking. The radiant barrier shall be laminated and perforated by the manufacturer to allow moisture/vapor transfer through the roof deck.

In addition, the radiant barrier shall be installed to cover all gable end walls and other vertical surfaces in the attic.
- The attic shall be ventilated to:
  1. Conform to the radiant barrier manufacturer's instructions.
  2. Provide a minimum free ventilation area of not less than one square foot of vent area for each 150 square feet of attic floor area.
  3. Provide no less than 30 percent upper vents.

Ridge vents or gable end vents are recommended to achieve the best performance. The material should be cut to allow for full airflow to the venting.

- The radiant barrier (except for radiant barriers laminated directly to the roof deck) shall be installed to have a minimum gap of 3.5 inches between the bottom of the radiant barrier and the top of the ceiling insulation to allow ventilation air to flow between the roof decking and the top surface of the radiant barrier, and have a minimum of six (6) inches (measured horizontally) left at the roof peak to allow hot air to escape from the air space between the roof decking and the top surface of the radiant barrier.
- When installed in enclosed rafter spaces where ceilings are applied directly to the underside of roof rafters, a minimum air space of 1 inch shall be provided between the radiant barrier and the top of the ceiling insulation, and ventilation shall be provided for every rafter space. Vents shall be provided at both the upper and lower ends of the enclosed rafter space.
- The product shall meet all requirements for California certified insulation materials (radiant barriers) of the Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation, as specified by CCR, Title 24, Part 12, Chapter 12-13, Standards for Insulating Material.
- The use of a radiant barrier shall be listed in the *Special Features and Modeling Assumptions* listings of the CF-1R and described in detail in the ACM Compliance Supplement.

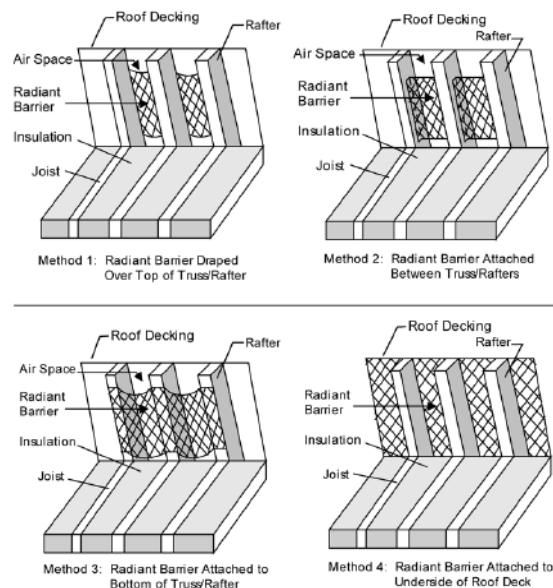


Figure 3-12 – Methods of Installation for Radiant Barriers

### 3.3.3 Radiant Barriers

#### ***Radiant Barrier Requirements***

§151(f)2

The prescriptive requirements call for a radiant barrier in climate zones with significant cooling loads (2, 4, and 8 through 15). The radiant barrier is a reflective material that reduces radiant heat transfer caused by solar heat gain in the roof. Radiant barriers reduce the radiant gain to air distribution ducts and insulation located below the radiant barrier. In the performance approach, radiant barriers are modeled as separate adjustments to the heating U-factor and the cooling U-factor. The duct efficiency is also affected by the presence of a radiant barrier, with the performance approach.

#### ***Radiant Barrier Construction Practice***

To qualify, a radiant barrier must have an emittance of 0.05 or less. The product must be tested according to ASTM C-1371-98 or ASTM E408-71(2002) and must be certified by the Department of Consumer Affairs<sup>2</sup>. Radiant barriers must also meet installation criteria as specified in Section 4.2.1 of the *Residential ACM Manual* (Section 4.2.1 is also reproduced in Appendix D of this document).

The most common way of meeting the radiant barrier requirement is to use roof sheathing that has a radiant barrier bonded to it in the factory. Oriented strand board (OSB) is the most common material available with a factory-applied radiant barrier. The sheathing is installed with the radiant barrier (shiny side) facing down toward the attic space. Alternatively, a radiant barrier material that meets the same ASTM test and moisture perforation requirements that apply to factory-laminated foil can be field-laminated. Field lamination must use a secure mechanical means of holding the foil to the bottom of the roof decking such as staples or nails that do not penetrate all the way through the roof deck material.

Other acceptable methods are to drape a foil type radiant barrier over the top of the top chords before the sheathing is installed, stapling the radiant barrier between the top chords after the sheathing is installed, and stapling the radiant barrier to the underside of the truss/rafters (top chord). For these installation methods, the foil must be installed with spacing requirements as described in Section 4.2.1 of the *Residential ACM Manual*. The minimum spacing requirements do not apply to this installation since it is considered a "laminated" system.

Installation of radiant barriers is somewhat more challenging in the case of closed rafter spaces when sheathing is installed that does not include a laminated foil. Foil may be field-laminated after the sheathing has been installed by "laminating" the foil as described above to the roof sheathing between framing members. This construction type is described in the *Residential ACM Manual*, Section 4.2.1.

See Figure 3-12 for drawings of radiant barrier installation methods.

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<sup>2</sup> Certification of radiant barriers is required by CCR, Title 24, Part 12, Chapter 12-13, Standards for Insulating Material.